

are accelerated by an electric field obtained by overlapping Vdc and the rf voltage which changes with time. The maximum ion energy which can be obtained varies depending on whether the motion of the ions follows the change with time of the rf voltage. Generally, the density of a plasma used for etching is equal to or higher than $1 \times 10^{10} \text{cm}^{-3}$. With such a density, the ions travel through the plasma sheath and reach the sample during the period in which the rf voltage is negative, that is, during a period of $\frac{1}{2}$ of the sine wave when the rf bias frequency is 15 MHz or lower. Emax is therefore almost equal to a value obtained by adding Vdc to the value of $\frac{1}{2}$ of the voltage amplitude ($V_{pp}/2$). In reality, there is a voltage drop or the like in an electric circuit. It is known from measurement that Emax is 400 eV when Vpp is 500V. Since a substantial physical quantity which exerts an influence on the etch profile is not Vpp but the ion energy, in order to obtain a profile without any microtrench, it is sufficient to set the maximum value of the ion energy to 400 eV or higher. When the frequency of the rf bias increases and the motion of the ions does not follow the change in voltage, Emax gradually approaches Vdc. A period during which the frequency is from 15 MHz to a few tens of MHz is a transient period. In such a case as well, if Vpp is set to 800V or higher, Emax sufficiently becomes 400 eV or higher.

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Page 26, please amend the paragraph beginning at line 14 as follows:

The structures of plasma etchers to which the invention can be applied will be described. Since the invention aims to process a device whose minimum feature size is $1 \mu\text{m}$, preferably, $0.5 \mu\text{m}$ or smaller, the effects are displayed when the invention is applied to a machine of a so-called high-density type in which the plasma electron density is $1 \times 10^{10} \text{cm}^{-3}$ or higher, preferably, $1 \times 10^{11} \text{cm}^{-3}$ or higher. As plasma etchers of this type, there are an inductively coupled plasma etcher and an ECR etcher. A capacitively coupled plasma etcher, which has been known for a

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long time, has problems as described below and is not adapted to the invention. Since such an etcher cannot generate a high density plasma, the throughput is low. Since the plasma density is low, the sheath becomes thick and the ions are scattered in the sheath, thereby deteriorating the degree of anisotropy. Since the plasma cannot be generated in a region where the gas pressure is low, the ions scatter considerably.

Page 37, please amend the paragraph beginning at line 21 as follows:

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By using a high density plasma having an electron density of the plasma of $1 \times 10^{10} \text{cm}^{-3}$ or higher, an etching having a high throughput can be carried out.

IN THE CLAIMS:

Please amend claims 1, 2, 4, 6 and 7 as follows:

1. (amended) A method of treating a surface of a sample having a gate electrode film and a film underlying the gate electrode film and provided on a Si substrate, comprising the steps of:

arranging the sample on a stage provided in a chamber;

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continuously supplying an etching gas into the chamber and generating a plasma from the etching gas;

applying an rf bias at a frequency of 100 kHz or higher to the stage independently of the generation of the plasma; and

on-off modulating the rf bias at a frequency of 100 Hz to 10 kHz to perform etching treatment of the sample in which a minimum feature size of the gate electrode film is $1 \mu\text{m}$ or smaller and a thickness of the underlying film is 6 nm or smaller.